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PATENT APPLICATION

Optical Pickup Diffracting One of Two Laser Beams to a Single Detector

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Optical Pickups Diffracting One of Two Laser Beams to a Single Detector

CROSS-REFERENCES TO RELATED APPLICATIONS

[01] NOT APPLICABLE

STATEMENT AS TO RIGHTS TO INVENTIONS MADE UNDER FEDERALLY SPONSORED RESEARCH OR DEVELOPMENT

[02] NOT APPLICABLE

REFERENCE TO A "SEQUENCE LISTING," A TABLE, OR A COMPUTER PROGRAM LISTING APPENDIX SUBMITTED ON A COMPACT DISK.

[03] NOT APPLICABLE

BACKGROUND OF THE INVENTION

[04] The present invention relates to optical pickups that work with both CDs and DVDs, and in particular to a design allowing the use of a single detector.

[05] Digital Versatile Disc (DVD) is a new format for storing video information. One of such disc can store a movie lasting more than two hours. In order to read the densely recorded digital data from DVD discs, the laser spot on the disc must be less than 0.55μm. This requires using a laser with 650nm wavelength or less and an objective lens with numerical aperture (NA) of 0.6 in the optical pickup. To facilitate the design of such a lens, the thickness of the DVD disc was specified to be 0.6mm instead of the 1.2mm thickness for CD discs. The differences between a DVD optical system and a CD optical system are summarized in Table 1.

	CD	DVD
Laser Wavelength (λ)	780nm	650nm
Numerical Aperture (NA)	0.45	0.6
Spot size (λ/2NA)	0.87μm	0.54μm
Disc thickness	1.2mm	0.6mm

TABLE 1

[06] It is difficult to design an objective lens to properly focus a laser beam through two substrates with different thickness. Fortunately, this difficulty is solved by researchers in this

reference article: Jang-hoon Yoo et.al. "An Optical Head with Special Annular Lens for Laser Disc-Compatible Digital Versatile Disc Pickup" Jpn. J.Appl. Phys. Vol. 37, pp.2184-2188, Part 1 No. 48, April 1988. With this particular objective lens design, a DVD optical pickup using 650nm laser can read both the CD disc and the DVD disc. However, for historical reasons, the CD-Recordable (CD-R) discs contain a dye, which can only be detected by 780nm lasers. As a result, most DVD optical pickups today contain two lasers: one with 780nm wavelength for reading the CD discs including the CD-R and CD-RW discs and one with 650nm wavelength for reading DVD discs.

[07] In a traditional one laser system such as shown in Fig. 1 there is only one optical axis. The light emitted by the laser package 101 will pass through a 3-beam grating 102. The laser light is then reflected by half mirror 103, collimated by a lens 104 and finally focused by objective lens 105 to medium 106. The light reflected by the medium 106 again passes through lenses 105 and 104. A portion of this reflected light is transmitted through the half mirror 103 and focused on detector 107.

[08] A typical pattern on the detector is shown in Fig. 1(b). Light sensitive elements, 107a, 107b, 107c and 107d are for detecting the focusing condition of the objective lens as well as the information read from the disc. Light sensitive elements, 107e and 107f are for detecting tracking error signals.

[09] As illustrated in Fig. 2, one of the difficulties in having two lasers in the same optical pickup is the need to use a dichroic beam splitter to efficiently combine the light emitted by the two lasers. The dichroic beam splitter 201c will reflect 100% of the light beam from laser chip 201b and transmit 100% of the light beam from laser chip 201a. The cube dichroic beam splitter requires bonding two highly polished prisms with proper dielectric coating together to form a cube. As a result, the cost of dichroic beam splitter is high. The advantage of using a dichroic beam splitter to combine two laser beams is that after combination, both beams appear to come from the same point source and propagate along the same optical axis. Both beams are reflected by the medium and are focused on the detector 207. In manufacturing such an optical pickup, the position of the detector 207 is aligned to the first laser. The position of the second laser must then be adjusted so that its beam is focused properly on the same detector.

[10] Recently, semiconductor laser manufacturers came out with a package that contains both a 780nm laser chip and a 635-650nm laser chip. The emitting point of the laser is separated by about 120μm (micrometer) as shown in Fig. 3. Laser chip 302 and laser chip 303 are mounted side by side on heat sink 301, which is part of the laser package 300. A

preferred arrangement is to have the laser channels at equal distances from the center axis 304 of the package. Of course, it is also possible to have the laser channel of chip 303 on the center axis and the laser channel of chip 302 off to one side of the center axis. A detector 305 is used to detect the back emission from both lasers. Such a twin laser package is used to replace the single laser package 101 in an optical pickup as shown in Fig. 1. The optical system with the twin laser package in most aspects remains unchanged except for the detector package 107.

[11] Because the two laser emitting points are separated in space, their images on the detector are similarly separated. As a result, a new detector pattern as shown in Fig. 4 is needed. Two sets of quadrant detectors are used to detect the returned beams from each of the lasers. The difficulty with this approach is that there is a manufacturing tolerance on the separations between the two laser chips. As a result, it is difficult to align the two beams perfectly on the detectors with a fixed separation. If the separation of the laser chips varies, the separation of the detectors on the detector chip would need to vary by the same amount. A standard detector chip with a standard separation of the detectors will suffer performance degradation if the lasers are not precisely mounted at the appropriate separation.

An example of a system with two lasers for CD and DVD which uses a diffraction grating to project return beams from two lasers onto two different detectors is set forth in Sanyo U.S. Patent No. 5,717,674.

BRIEF SUMMARY OF THE INVENTION

[12] It is the purpose of this patent application to solve the aforementioned problem. A grating is placed at a slight distance in front of the detector. A single, 4-quadrant detector is used to detect the returned beams from both lasers. The returned beam of the first laser passes through the grating element undiffracted, by passing through a portion without a grating pattern. The position of the detector is aligned with respect to this first beam. The grating diffracts the returned beam from the second laser to the same detector. The separation of the grating to the detector can be adjusted so that the returned beam from the second laser is also perfectly aligned to the detector.

[13] In manufacturing, the separation of the laser sources is set to a typical distance such as 150 micrometers, and an appropriate grating created for that separation. During manufacturing, the diffraction element is adjusted along the optical axis to correct for the small error in the separation of the two laser chips.

BRIEF DESCRIPTION OF THE DRAWINGS

[14] Fig. 1 (a) illustrates a prior art single laser optical pickup.

[15] Fig. 1 (b) illustrates a typical prior art detector.

[16] Fig. 2 illustrates a prior art two-lasers optical pickup.

[17] Fig. 3 illustrates a prior art dual laser package.

[18] Fig. 4 illustrates a prior art detector used with the dual laser package.

[19] Fig. 5 (a) illustrates a preferred embodiment of an optical pickup of this present invention.

[20] Fig. 5 (b) illustrates a detailed view of the grating and detector of the optical pickup of Fig. 5.

[21] Fig. 6 illustrates a second preferred embodiment of the detector for this present invention.

DETAILED DESCRIPTION OF THE INVENTION

[22] In Fig. 5(a) the laser package 501 contains two laser chips similar to the package in Fig. 3. The laser beams, after passing through a 3-beam grating 502, are reflected by the half mirror (beam-splitter) 503. The beams are then collimated by a collimating lens 504 and focused by the objective lens 505 onto the medium 506. To simplify the discussion, a first laser is set along the optical axis of the objective lens. The returned beams, after passing through again the objective lens and the collimating lens, are transmitted through the half mirror. Both beams are intercepted by a grating glass 508 before being projected on the detector 507.

[23] Fig. 5(b) shows the details of the two returned beams. The line 510 is the optical axis of the first laser and the line 511 is the optical axis of the second laser. The grating glass 508 is placed at a distance from the detector 507 such that the two returned beams are separated in space. In a first embodiment of the present invention a grating 509 is etched on the grating glass 508 in such a manner that it only intercepts the returned beam 511. Since the beam with optical axis 510 is not intercepted by grating 509, it passes through 508 without deviation and falls on detector 507. Grating 509 diffracts the beam 511 into two beams 512 and 513. By means of the grating 509, the beams from the first laser 510 and the second laser 511 are brought into coincidence on the same detector 507. As a result, the same detector as shown in Fig. 1(b) can be used for both laser sources. In this present invention the two laser beams are combined on the detector plane without the use of a dichroic beam splitter. In a second embodiment, both beam will pass through grating 509. However, the grating is made

in such a manner that the grating is transparent to the beam 510 with a first wavelength and diffracts the beam 511 with the second wavelength.

[24] In a typical use, the optical pickup is reading either a CD or a DVD, so only one of those laser signals needs to be read at a time.

[25] In manufacturing, a single diffraction element could be used, but its distance from the detector (adjusting along the optical axis) could be varied to compensate for the difference in spacing between the laser sources. This same method could be applied with both beams being diffracted. The varying distance could compensate for different separations of the laser source.

[26] Either laser could be the one to have its beam diffracted. In a preferred embodiment, the 780nm beam is diffracted, because its signal is typically stronger, and can better afford to have some reduced intensity by diffraction.

[27] Fig. 6 shows a second embodiment of a detector for this present invention. In addition to the detector a, b, c, d, e and f in Fig. 1(b), detector g is added to collect the diffracted beam 513. The signal generated by detector g can be added to the sum of the signal from detectors a, b, c and d to increase the level of the high frequency signal when the second laser is used. The sum signal is the signal used to give the data, whether it is a digital one or zero. The g signal would not be combined with the signals from each quadrant, which are used for focus error correction.

[28] As will be understood by those of skill in the art, the present invention may be embodied in other specific forms without departing from the essential characteristics thereof. For example, the two lasers could be in separate packages, or a different number of detector quadrants could be used. Alternately, the laser beams could be on either side of the optical axis of the objective lens, instead of one being on that axis. Additionally, instead of correcting by adjusting along the optical axis, the pattern of the grating could be modified. Accordingly, the above description is intended to be illustrative, but not limiting, of the scope of the invention which is set forth in the following claims.